Northern Ireland Statistics and Research Agency
Gníomhaireacht Thuaisceart Éireann um Staitisticí agus Taighde

Department of Finance | An Roinn Airgeadais

Northern Ireland Multiple Deprivation Measures 2017

Technical report

Contents

1 INTRODUCTION

1.1 The Northern Ireland Statistics and Research Agency (NISRA) carried out research to identify small area concentrations of multiple deprivation in Northern Ireland. The resulting measure, the Northern Ireland Multiple Deprivation Measure (NIMDM) 2017, replaces the NIMDM 2010 as the official measure of spatial deprivation in Northern Ireland.

1.2 The NIMDM 2017 provides information on seven types or 'domains' of deprivation and an overall multiple deprivation measure comprising a weighted combination of the seven domains. The majority of results are presented at the Super Output Area geography.

1.3 This report presents the framework of the NIMDM 2017; the methodology for creating the domains and the overall Multiple Deprivation Measure; the component indicators and domains and the quality assurance carried out to ensure reliability of the data outputs. A summary of the methodology is provided in Annex A.

1.4 Separate publications will follow providing results as well as guidance on the use of the measures, particularly with respect to change over time; and on recommendations for the creation of future spatial measures of deprivation. A series of dissemination events are planned for the winter 2017/18 and will be advertised via the NISRA website.

1.5 NIMDM 2017 provides an updated area based measure (i.e. spatial) of relative deprivation for small areas within NI. It will provide a mechanism for identifying areas in the order of most deprived to least deprived. As such, it will highlight which areas are more (or less) deprived than others, but not by how much. This is also the case for each of the seven separate domain measures associated with the NIMDM 2017.

1.6 NIMDM 2017 is based on indicators that consider the aggregate characteristics of the people living in an area as well as, in some cases, the characteristics of the area itself.

1.7 As NIMDM 2017 is an area based measure, it will not identify individuals who are deprived; rather, it identifies areas where there are relative concentrations of several different types of deprivation.

1.8 The NIMDM 2017 methodology recognises that there will be people who may be regarded as deprived but are living in areas which have been ranked as the least deprived. Similarly, it recognises that there will be people who may not be regarded as deprived but are living in areas which have been ranked as the most deprived.

1.9 In developing the NIMDM 2017 and the seven associated separate domain measures, every effort has been made to capture the relevant indicator data at the lowest geographical level possible so that pockets of deprivation can be more readily identified.

1.10 The NIMDM 2017 ranks do not give a measure of the amount of deprivation in an area. As such it does not allow for statements such as, “area A is twice as deprived as area B”. The ranks can however be used to say that “area A is more deprived that area B”. This is particularly important when trying to draw inferences from successive measures of deprivation over time (e.g. NIMDM 2010 and NIMDM 2017). Even though an area’s rank may have stayed the same between successive measures, the level of deprivation may have increased or decreased but just not enough to affect the comparison and relative ranking to other areas. Having said that, the analysis of the individual indicators does allow for such comparisons between areas over time provided the indicators are comparable.

2 HOW CAN THE NIMDM 2017 BE USED?

2.1 What the NIMDM 2017 **<u>can</u>** be used for

For each individual domain of deprivation and the overall MDM, the rankings can be used to:

- ✓ Explore the relative deprivation of small geographical areas by comparing them with each other
- ✓ Explore which small geographical areas are the most or least deprived
- ✓ Examine the spatial distribution of small geographical areas that are the most or least deprived, however defined
- ✓ Explore which small geographical areas have joined, left or remained in the most or least deprived areas over time

This can be done for Northern Ireland as a whole, or for each individual Local Government District or for other large geographies

2.2 What the NIMDM 2017 **<u>cannot</u>** be used for

- × Identifying deprived individuals or groups of people – these are area based spatial measures
- × Quantifying the extent to which a small geographical area is deprived – they provide relative rankings of areas
- × Quantifying the extent to which one area is more or less deprived than another – they provide relative rankings of areas
- × Assessing how absolute deprivation in a small geographical area has changed over time – they provide a spatial ranking at a single point in time
- × Measuring affluence – lack of deprivation is not the same as being affluent
- × Undertaking UK comparisons – each UK country has a different set of indicators, time periods, domains and domain weights.

3 CRITERIA FOR INDICATORS

3.1 Each of the 7 domains (i.e. Income, Employment, Health & Disability, Education, Skills & Training, Access to Services, Living Environment and Crime & Disorder) consists of one or more indicators that are considered to encapsulate that particular type of deprivation. In order to be considered for inclusion, each indicator should conform to the following six criteria:

a) It should be specific to one of the seven domains of deprivation thus avoiding double counting and attaching undue weight to any particular indicator.

b) It should represent major features of that form of deprivation rather than deprivation affecting a small number of people or particular types of area in Northern Ireland. This allows the degree of deprivation to be identified as opposed to a simple 'present/ not present' approach.

c) It should be available for all of Northern Ireland, collected in a consistent form and be free from spatially bias characteristics.

d) It should represent either a direct measure or a good proxy of that form of deprivation.

e) It should be statistically robust at the small area level, facilitating the identification of 'pockets' of deprivation.

f) It should be as up to date as possible.

3.2 These criteria – unchanged since NIMDM 2001 and also used in Indices of Multiple Deprivation in the rest of the UK – were highlighted in the consultation document and have been used by the deprivation team and the domain expert groups to assess the suitability of the proposed indicators and additional indicators raised during the consultation.

4 CONSULTATION

4.1 As part of its work to update the current Northern Ireland Multiple Deprivation Measure (NIMDM 2010), NISRA consulted users about the proposed indicators to be included in the updated measures, referred to as NIMDM 2017.

4.2 The consultation document was downloaded 167 times, around 60 people attended the information sessions, and 28 written responses were received from a range of organisations. The responses were analysed and discussed with domain expert groups and the Steering Group, resulting in a final set of indicators for the forthcoming NIMDM 2017.

4.3 Following consultation responses, two proposed indicators were removed from the Health Deprivation and Disability Domain, one indicator was added to the Crime and Disorder Domain, and one service was added to the travel time indicators in the Access to Services Domain.

4.4 The consultation also collected views on the domain weights. The Steering Group considered these views, but found insufficient basis for changing the weights used in the most recent two Multiple Deprivation Measures.

4.5 The NIMDM 2010 consisted of 30 indicators, 19 of which have been retained in the updated measures. A further 8 were modified in line with newly available data, while 3 have been omitted due to data quality and/or availability issues. A total of 11 new indicators have been added, as a result of addressing the 2010 recommendations or as a result of new information becoming available. This has resulted in a suite of 38 indicators in NIMDM 2017.

4.6 An earlier consultation was held in spring 2016 to gather views on the preferred output geography of the forthcoming deprivation measures. Based on the responses, it was decided to (1) retain Super Output Areas as the main output geography of the updated Multiple Deprivation Measure, and (2) create and publish deprivation measures for the new Electoral Wards on an approximate basis after the main release.

INCOME DEPRIVATION DOMAIN

Purpose of the Domain

5.1 The purpose of the Income Deprivation Domain is to identify the proportion of the population on low income at the small area level.

Indicators for NIMDM 2017

5.2 The Income Domain consists of one indicator:

> The proportion of the population living in households whose equivalised income is below 60 per cent of the NI median
> *(2015/16; Source: DfC)*

5.3 Supporting information has also been produced in respect of income deprivation affecting children (i.e. those aged 15 and under) and older people (i.e. those aged 65 and over) showing:

- the proportion of the population aged 15 and under living in the households identified above; and
- the proportion of the population aged 65 and over living in the households identified above.

Changes since NIMDM 2010

5.4 The purpose of the Income Deprivation Domain is to identify the proportion of the population experiencing income deprivation at the small area level. In NIMDM 2010, this proportion was calculated by obtaining a non-overlapping count of individuals living in households in receipt of income related benefits and tax credits. However, the Department for Communities (DfC) have since developed a database to allow measurement of household incomes. This means that the measurement of income deprivation no longer relies solely on benefit data.

5.5 The DfC Database for Income Modelling and Estimation (DIME) contains income from employment; self-assessment (including self-employment and investment); work-related pension schemes; social security benefits; savings; and tax credits. It does not however include information on loans.

5.6 There are multiple steps taken by the Deprivation team – building on the work by, and in partnership with the Department for Communities – to process the DIME data for the particular use of creating a spatial ranking of areas. These include improving the geo-spatial referencing of households, standardising the regional differences in housing benefits, correcting for past overpayments of benefits, and correcting for negative incomes (losses) from self-assessments. Finally, and on advice of DfC, 3,800 households with an equivalent income less than £100 per week were excluded from the analysis, as such households seem to be overrepresented in the DIME when compared to the Family Resource Survey.

5.7 The indicator is strongly aligned to the accepted definition of relative poverty[1], except that it uses the NI median income from the dataset of around 700,000 NI households rather than the UK median income from a UK wide survey of 20,000 households. Household incomes have been equivalised[2] to take into account variations in the size and composition of the households in which individuals live.

5.8 In the finalised dataset, the median equivalised income was £24,253 per year. The threshold of 60 per cent of the NI median then becomes £14,522 per year or £280 per week. This figure is similar to the £288 per week reported in the Northern Ireland Poverty Bulletin[3], based on the UK-wide Family Resource Survey. As this is an equivalised income, it applies to a two-adult household without children. For a single-adult household, this becomes £187 per week.

[1] See https://www.communities-ni.gov.uk/sites/default/files/publications/communities/ni-poverty-bulletin-201415.pdf#page=5

[2] See https://www.communities-ni.gov.uk/sites/default/files/publications/communities/hbai-2014-15-quality-methodology-information-report.pdf#page=12

[3] See https://www.communities-ni.gov.uk/sites/default/files/publications/communities/ni-poverty-bulletin-201516.pdf

EMPLOYMENT DEPRIVATION DOMAIN

Purpose of the Domain

6.1 The purpose of the Employment Deprivation Domain is to identify the proportion of the working age population excluded from work at the small area level.

Indicators for NIMDM 2017

6.2 The Employment Deprivation Domain consists of one indicator, namely, the proportion of the working age population (i.e. those aged 18-64 for both males and females) who are either (a) in receipt of at least one of the selected benefits outlined below, or (b) who are not in receipt of the selected benefits and have not received income from employment.

6.3 The selected benefits were:

Job Seeker's Allowance.
(2015/16; Source: DfC)

Incapacity Benefit.
(2015/16; Source: DfC)

Severe Disablement Allowance.
(2015/16; Source: DfC)

Carer's Allowance.
(2015/16; Source: DfC)

Employment and Support Allowance.
(2015/16; Source: DfC)

Changes since NIMDM 2010

6.4 In the NIMDM 2010, the employment deprivation indicator was calculated by obtaining a count of the working age population who are in receipt of at least one of the selected benefits. The first change is the removal of Steps to Work participants. Steps 2 Success (S2S) was introduced in October 2014, replacing the Steps to Work (StW) programme. StW was included in the previous measures to capture those not claiming Jobseeker's Allowance (JSA), but who were actively seeking employment. However, 99 per cent of those who are in the current S2S Programme are claiming JSA and will already be included. Therefore, S2S participants are not included in this domain.

6.5 The NIMDM 2010 indicators assumed working age to be 18-59 for women and 18-64 for men. Since 2010 the eligibility for working age benefits has changed in line with the pension age. To reflect this change, NIMDM 2017 has assumed working age to be all persons aged 18-64.

6.6 In NIMDM 2017, the employment deprivation indicator has been augmented with the 'hidden unemployed', which in this context is defined as those who are not in receipt of any of the above selected benefits, nor have received income from employment. Such individuals can be identified in the Database for Income Modelling and Estimation (DIME), as used in the Income Domain.

6.7 In total, 206,400 people were found to be in receipt of the selected benefits, with an additional 26,600 people identified who are not in receipt of any of the above selected benefits, nor have received income from employment.

Health Deprivation and Disability Domain

Purpose of the Domain

7.1 The purpose of the Health Deprivation and Disability Domain is to identify rates of premature deaths, and proportions of the population's quality of life impaired by poor health or disability at the small area level.

Indicators for NIMDM 2017

7.2 The Health Deprivation and Disability Domain consists of nine indicators, including one combined mental health indicator, as detailed below:

Standardised preventable death ratio (excluding Suicides)
(2012 to 2016; Source: GRO)

Standardised physical health-related benefit ratio[4] (formerly Comparative Illness and Disability Ratio)
(2015/16; Source: DfC)

Standardised ratio of cancer registrations (excluding non-melanoma skin cancers)
(2011 to 2015; Source: Northern Ireland Cancer Registry)

Standardised emergency admission ratio
(2015/16; Source: DoH)

Proportion of Singleton Births with Low Birth Weight
(2012 to 2016; Source: Child Health System)

Standardised ratio of Children's Dental Extractions
(2013/14 to 2015/16; Source: BSO and DoH)

Standardised ratio of people on multiple prescriptions on a regular basis
(2016; Source: BSO)

[4] This ratio is based on a non-overlapping count of recipients of the following benefits: Income Support (in receipt of disability premium), State Pension Credit (disability premium), Attendance Allowance, Severe Disablement Allowance, Disability Living Allowance, Incapacity Benefit and Employment and Support Allowance.

Standardised ratio of people with a long-term health problem or disability (Excluding Mental Health problems)
(2011; Source: Census)

Combined Mental Health Indicator

Standardised ratio of population in receipt of prescriptions for mood and anxiety disorders
(2016; Source: BSO)

Standardised suicide rate
(2007 to 2016; Source: GRO)

Standardised rate of mental health inpatient stays
(2011/12 to 2015/16; Source: DoH)

Standardised mental health related benefit ratio
(2015/16; Source: DfC)

Standardised proportion of people with Mental Health problems
(2011; Source: Census)

Changes since NIMDM 2010

7.3 The NIMDM 2010 health domain contained 7 indicators. Five of these indicators have been included in the NIMDM 2017 unchanged.

7.4 The standardised health-related benefit ratio now excludes people in receipt of Disability Living Allowance where mental health is the main reason as this is one of the data sources in the combined mental health indicator.

7.5 ‘Standardised Potential Years of Life Lost’ has been replaced by the ‘Standardised preventable death rate’. The consultation had proposed that the Standardised preventable death rate and an indicator relating to drug and alcohol related deaths be added to the domain, in addition to the ‘Standardised Potential Years of Life Lost’. However, the domain expert group decided to remove ‘Drug and alcohol related deaths’ as they are picked up within the other indicators. The group also reflected on the overlap between the ‘Potential years of life

lost' indicator and the 'Preventable deaths' indicator. In view of the risk of double counting, the preference is the preventable mortality indicator, which aligns with the draft Programme for Government.

7.6 Two new indicators have been added to the NIMDM 2017 Health Deprivation and Disability Domain, namely the 'Standardised proportion of people on multiple prescriptions on a regular basis' and the 'Standardised proportion of people with a long-term health problem or disability'.

7.7 Following advice from the Department of Health (DoH) the Standardised Proportion of people on multiple prescriptions indicator will be defined as people receiving 5 or more prescriptions, 3 out of 4 quarters including the first and last.

7.8 The standardised proportion of people with a long-term health problem or disability comes from the 2011 Census which captured information on the prevalence of a range of disabilities including deafness, blindness, mobility and learning difficulties. This indicator has been added to the domain and as in the health related benefits indicator, this indicator includes only physical health problems and disabilities. The 'Standardised proportion of people with Mental Health problems' has been added to the combined mental health indicator.

Combination of indicators

7.9 The domain comprises of 9 indicators, each relating to a specific aspect of health deprivation or disability. The aim of the domain is not to create a count of health deprived or disabled people, as in the income and employment domain, as clearly one person could be captured in multiple indicators. Instead, the analysis supposes that there is an underlying but unknown ranking of areas in terms of health deprivation, to which the rankings of indicators are related. Factor analysis was used to determine the weights for each of the indicators' rankings in the Health Deprivation and Disability Domain (see table below). The five mental health datasets were also combined using factor analysis to form a single indicator.

7.10 All indicators were ranked and their ranks transformed to a standard normal distribution (see Annex B). The transformed ranks were then combined, through weights determined by factor analysis (see Annex C), to provide an overall rank. The resulting scores were then ranked to form the Health Deprivation and Disability Rank.

Indicator Weights[5]

Standardised preventable death ratio (excluding Suicides)	0.03
Standardised physical health-related benefit[6] ratio (formerly Comparative Illness and Disability Ratio)	0.32
Standardised ratio of cancer registrations (excl. non-melanoma skin cancers)	0.01
Standardised emergency admission ratio	0.02
Proportion of Singleton Births with Low Birth Weight	0.01
Standardised ratio of Children's Dental Extractions	0.02
Standardised ratio of people on multiple prescriptions on a regular basis	0.06
Standardised ratio of people with a long-term health problem or disability (Excluding Mental Health problems)	0.11
Combined Mental Health Indicator	0.42
Standardised ratio of population in receipt of prescriptions for mood and anxiety disorders	0.10*
Standardised suicide ratio	0.01*
Standardised ratio of mental health inpatient stays	0.01*
Standardised mental health related benefit ratio	0.14*
Standardised ratio of people with Mental Health problems	0.15*

**weights are as a proportion of the combined mental health indicator*

[5] Weights do not add up to 1.00 due to rounding.

[6] This ratio is based on a non-overlapping count of recipients of the following benefits: Income Support (in receipt of disability premium), State Pension Credit (disability premium), Attendance Allowance, Severe Disablement Allowance, Disability Living Allowance, Incapacity Benefit and Employment and Support Allowance.

Education, Skills and Training Deprivation Domain

Purpose of the Domain

8.1 The purpose of the Education, Skills and Training Deprivation Domain is to identify the prevalence of poor educational outcomes for children and low levels of qualifications for working age adults at the small area level.

Indicators for NIMDM 2017

8.2 The Education, Skills and Training Deprivation Domain consists of eight indicators

Proportions of pupils attending Special Schools or attending primary school with Special Education Needs Stages 3-5
(2014/15 to 2015/16; Source: School Census, DE)

Absenteeism at Primary Schools
(2014/15 to 2015/16; Source: DE)

Proportions of school leavers not achieving 5 or more GCSEs at A*-C (and equivalent) including English and maths
(2013/14 to 2015/16; Source: School Leavers Survey, DE)

Proportions of those leaving school aged 16, 17 and 18 and not entering Education, Employment or Training
(2013/14 to 2014/15; Source: School Leavers Survey, DE)

Proportions of 18-21 year olds who have not enrolled in Higher Education Courses Higher Education or Further Education establishments
(2012/13 to 2015/16; Source: HESA and FESR, DfE)

Proportions of pupils attending Special Schools or who are attending post-primary schools with Special Education Needs Stages 3-5
(2014/15 to 2015/16; Source: School Census, DE)

Absenteeism at post-primary schools
(2014/15 to 2015/16; Source: DE)

Proportions of working age adults (25-64) with no or low levels of qualification
(2011; Source: NISRA)

Changes since NIMDM 2010

8.3 The NIMDM 2010 Education, skills and Training Domain contained 10 indicators split into three sub domains; Primary school, Post primary school and Working age adults. Seven of these indicators will remain in the NIMDM 2017 domain unchanged, two have been removed and one modified.

8.4 A recommendation following the NIMDM 2010 was that the GCSE attainment indicator should be modified to focus on English and Mathematics. The Domain Expert Group decided to update the indicator from 'GCSE and equivalent point scores' to the 'proportion of school leavers achieving less than 5 GCSEs at A*-C (and equivalent) including GCSE English and Maths', as used in the Programme for Government.

8.5 Two of the NIMDM 2010 indictors relating to Key Stage Assessments have been removed from the domain. The provision (and hence coverage) of Key Stage data was impacted by industrial action resulting in a limited number of returns being made to CCEA since 2013/14. The levels of coverage were not considered sufficient to support the robust small area analyses required for NIMDM 2017. Accordingly, the indicators relating to Key Stage 2 and 3 attainment were removed.

8.6 Due to the absence of Key Stage 2 data, the primary sub-domain would contain only two indicators. This meant that, in the Primary School Sub-Domain only, the data driven method (i.e. Factor Analysis) to determine the weights for each indicator could no longer be used, as this method requires at least three indicators. The Steering Group, supported by the domain expert group, decided that (in the circumstances) the indicators from all three sub-domains should be combined, thus facilitating the use of data driven methods. Therefore, there are no longer any sub-domains in the Education, Skills and Training Deprivation Domain.

Combination of indicators

8.7 As the sub domains were removed, all the indicators were combined and Factor Analysis was used to determine the weights (see table below). Under this approach, all of the indicators were ranked and their ranks transformed to a standard normal distribution (see Annex B). The transformed ranks were then combined with weights determined by factor analysis (see Annex C).

Indicator Weights

Proportions of pupils attending Special Schools or attending primary school with Special Education Needs Stages 3-5	0.05
Absenteeism at Primary Schools	0.13
Proportions of school leavers achieving less than 5 GCSEs at A*-C (and equivalent) including GCSE English and maths	0.20
Proportions of those leaving school aged 16, 17 and 18 and not entering Education, Employment or Training	0.04
Proportions of 18-21 year olds who have not enrolled in Higher Education Courses at Higher Education or Further Education establishments	0.14
Proportions of pupils attending Special Schools or who are attending post-primary schools with Special Education Needs Stages 3-5	0.05
Absenteeism at post-primary schools	0.21
Proportions of working age adults (25-64) with no or low levels of qualification	0.18

Access to Services Domain

Purpose of the Domain

9.1 The purpose of the Access to Services Domain – formerly known as the Proximity to Services Domain – is to measure the extent to which people have poor physical and online access to key services at the small area level.

Proposed Indicators for NIMDM 2017

9.2 The Access to Services Domain consists of three indicators:

Service-weighted fastest travel time by private transport
(2016; Source: DfI)

Service-weighted fastest travel time by public transport
(2016; Source: DfI)

Proportion of properties with broadband speed below 10Mb/s
(2016; Source: Ofcom)

9.3 The services to be included in the private transport travel time are:

Accident and Emergency hospital
(2016; Source: DoH)

Job Centre or Jobs and Benefits Office
(2016; Source: DfE)

Post Office
(2016; Source: Post Office Ltd)

Supermarket / Food Store
(2016; Source: IDBR)

Primary Schools
(2016; Source: DfE)

Post-Primary Schools
(2016; Source: DfE)

Council Leisure Centre
(2016; Source: DfC)

GP premises
(2016; Source: BSO)

Dentists
(2016; Source: BSO)

Pharmacists
(2016; Source: BSO)

Opticians
(2016; Source BSO)

Libraries
(2016; Source: DfC)

Day nurseries and Crèches
(2017; Source: Family Support NI)

Financial Services
(2016; Source: IDBR)[i]

Large Service Centres[7] *(2016; Source: NISRA)*	Other general services: Restaurants, fast-food outlets, pubs, filling stations, and health & beauty establishments *(2016; Source: IDBR)*

9.4 Public transport time will include the same services as the private transport with the exception of schools, A&Es and petrol stations: the public transport model does not include bespoke school bus routes and time tables, and it was postulated that for emergency treatment, people would not rely on public transport.

Changes since NIMDM 2010

9.5 The NIMDM 2010 Access to Services Domain (formally known as the Proximity to Services Domain) consisted of one indicator, namely the fastest road travel time to a list of services. In addition to the services included in NIMDM 2010, the NIMDM 2017 includes 4 new services; Libraries, Primary and Post Primary schools, and Day Nurseries and Crèches. Furthermore, whilst the centre of the former Census Output Areas were used as an approximation of the location of both the population and the services in NIMDM 2010, the new iteration is more fine-grained using the exact location of services and the centre of postcodes to approximate the location of usual residents. In total, there were 53,100 postcodes and 10,600 services, giving 563 million possible journeys, compared to 25 million combinations of the 5,022 Census Output Areas used in NIMDM 2010.

7 https://www.nisra.gov.uk/sites/nisra.gov.uk/files/publications/NIMDM_2010_description_of_indicators_domains_and_the_multiple_deprivation_measure.pdf#page=60

9.6 Two other indicators have also been added to the domain; Service-weighted fastest travel time by public transport and Proportion of properties with broadband speed below 10Mb/s.

9.7 The Service-weighted fastest travel time by public transport indicator will include the same services as the private transport with the exception of A&E, schools and petrol stations. Public transport includes bus, train, and ferry. Modelling assumptions include a journey to the service between 6am and 10am on a Tuesday and a maximum 20 minute walk to the public transport access point, as well as assumptions for connecting public transport.

9.8 The third indicator in the Access to Services is the Proportion of properties with broadband speed below 10Mb/s. Based on data from Ofcom, this indicator measures the proportion of properties which are unable to access a broadband speed of at least 10Mb/s. Ofcom state that *'a connection speed of 10Mbit/s is required to deliver an acceptable broadband user experience for a typical household'.*

Combination of indicators

9.9 Travel times to each of the services have been adjusted to take into account the average travel time that would be anticipated, given the number of locations at which the service is available. This technique prevents the less commonly available services from dominating the final result due to longer travel times. The Accident and Emergency indicator was given double weighted in line with NIMDM 2005 and NIMDM 2010.

9.10 The three indicators were ranked and their ranks transformed to an exponential distribution (See Annex D). Following discussion with the Steering Group and Domain Expert Group, each indicator was given an equal weight in the absence of a robust rationale for differing rates.

Indicator Weights[8]

Service-weighted fastest travel time by private transport	0.33
Service-weighted fastest travel time by public transport	0.33
Proportion of properties with broadband speed below 10Mb/s	0.33

[8] Weights do not add up to 1.00 due to rounding.

Living Environment Domain

Purpose of the Domain

10.1 The purpose of the Living Environment Domain is to identify, at the small area level, the prevalence of shortcomings in the quality of housing, access to suitable housing, and the outdoor physical environment.

Proposed Indicators for NIMDM 2017

10.2 The Living Environment Domain consists of nine indicators, grouped into three sub-domains:

Sub-Domain: Housing quality

Proportion of domestic dwellings that are unfit
(2016; Source: NIHE, modelled NI House Conditions Survey)

Proportion of domestic dwellings in a state of disrepair
(2016; Source: NIHE, modelled NI House Conditions Survey)

Proportion of domestic dwellings without (1) modern boiler, or (2) loft insulation and double glazing.
(2016; Source: NIHE, modelled NI House Conditions Survey)

Sub-Domain: Housing Access

Proportion of population in overcrowded households
(2011; Source: 2011 Census)

Proportion of population with disability without adaptations to dwelling
(2011; Source: 2011 Census)

Sub-Domain: Outdoor physical environment

Proportion of domestic dwellings with Local Area Problem Scores
(2016; Source: NIHE, modelled N I House Conditions Survey)

Standardised rate of road defects
(2014/15 to 2016/17; Source: DfI)

Road Traffic Collisions
(2006 to 2015; Source: PSNI)

Proportion of properties in flood risk area
(2013; Source: Rivers Agency)

Changes since NIMDM 2010

10.3 Due to timing issues, data relating to the Decent Home Standard and the Housing Health and Safety Rating Standard which were previously incorporated in NIMDM 2010 were not available in time for this update. The raw responses from the Housing Conditions Survey have been modelled and applied to the Land and Property database to develop indicators, representing the proportion of domestic dwellings that are 'unfit' or ' in a state of disrepair'.

10.4 The domain expert group was content that, in the circumstances, this alternative approach would help to address the information gap. The Outdoor Environment Sub-Domain is also derived from the House Conditions Survey, based on the Local Area Problem Score and the visual quality of the area. It includes problems such as the presence of litter and rubbish; graffiti; vandalism; dog fouling; scruffy or neglected gardens; scruffy or neglected buildings; and vacant or boarded-up buildings.

10.5 In line with the NIMDM 2010 recommendations the quality of the geographical coding of homeless data was investigated. The NI Housing Executive advised that it was unable to provide comprehensive data on the actual last permanent address of homeless applicants. Data on homeless presentations are reported by location of presentation (local office) rather than previous address. This means that any report on previous address would be patchy and

would not give a good basis for service planning. Therefore the Living Environment Domain no longer includes an indicator on homelessness acceptances.

10.6 Another recommendation following the NIMDM 2010 was to include an indicator relating to energy efficiency. The NIMDM 2005 included a measure of central heating as a measure of housing quality but suitable up to date small area measures of central heating did not exist at the time of the calculation of the NIMDM 2010. For the NIMDM 2017, the NI Housing Conditions Survey has been used to create a measure of energy efficiency. The indicator is the proportion of properties with either (1) no loft insulation and single glazing or (2) no central heating or a boiler that is more than 15 years old.

10.7 Following on from the NIMDM 2010, road quality was considered for inclusion in this domain and data relating to road surface defects have improved since the last update. To get a fuller picture of deprivation resulting from Road Quality information on both Road Surface defects and Road Traffic Collisions have been utilised in the domain.

10.8 Household overcrowding, as well as suitability of housing for the disabled, were also raised as issues to be considered in this update. The expert groups and consultation responses felt that these remain important issues and have therefore been included an indicators using data taken from the 2011 Census.

Combination of indicators

10.9 The indicators in the Housing Quality Sub-Domain are ranked and transformed to a normal distribution (see Annex B). Indicators are then combined using factor analysis (see Annex C) to produce a sub- domain score.

10.10 Indicators in the Housing Access Domain and the Outdoor Physical Environment Domain are not strongly correlated with each other. In order to combine them they are transformed to an exponential distribution (see Annex D) and combined within their sub-domain using equal weights.

Indicator Weights

10.11 The resulting sub-domain scores were ranked and transformed to an exponential distribution (see Annex D) and combined with equal weights. Again, there was no strong rationale for different weights from the consultation responses and discussions with the Domain Expert Group.

Sub-Domain: Housing quality (0.33)

Proportion of domestic dwellings that are unfit	0.10
Proportion of domestic dwellings in a state of disrepair	0.80
Proportion of domestic dwellings without (1) modern boiler, or (2) loft insulation and double glazing.	0.10

Sub-Domain: Housing Access (0.33)

Proportion of population in overcrowded households	0.50
Proportion of population with disability without adaptations to dwelling	0.50

Sub-Domain: Outdoor physical environment (0.33)

Proportion of domestic dwellings with Local Area Problem	0.25
Standardised rate of road defects	0.25
Road Traffic Collisions	0.25
Proportion of properties in flood risk area	0.25

Crime and Disorder Domain

Purpose of the Domain

11.1 The purpose of the Crime and Disorder Domain is to identify the rate of crime and disorder at the small area level.

Proposed Indicators for NIMDM 2017

11.2 The Crime and Disorder Domain will consist of six indicators, grouped into two sub-domains:

Sub-Domain: Crime

Violence (including sexual offences), robbery and public order
(2012 to 2016; Source PSNI)

Burglary
(2012 to 2016; Source PSNI)

Theft
(2012 to 2016; Source PSNI)

Vehicle Crime
(2012 to 2016; Source PSNI)

Criminal Damage and Arson
(2012 to 2016; Source PSNI)

Sub-Domain: Disorder

Deliberate Primary and Secondary Fires
(April 2011 to March 2016; Source: NIFRS)

Anti-Social Behaviour Incidents
(2012 to 2016; Source: PSNI)

Changes since NIMDM 2010

11.3 The Crime and Disorder Domain contains the same indicators as in 2010 with the addition of a Theft Indicator. Following the consultation, two respondents requested the inclusion of theft as an additional indicator in the crime sub-domain. The three crime categories that cover theft are bicycle theft, theft from the person (without the use or threat of physical force) and other theft (Including theft by an employee, blackmail and making off without payment). English and Welsh deprivation measures already include theft as an indicator in their crime / community safety domains. After discussion with the domain expert group, it was decided to include theft as the fifth indicator in the crime sub-domain

11.4 Since the NIMDM 2010, the Police Service for Northern Ireland has changed the categorisation of crimes to align with those used in England and Wales[9]. It is expected that the impact of this change was minimal for the purpose of the Crime and Disorder Domain.

11.5 The two indicators in the Disorder sub-domain have been combined with a 60 per cent weight for Anti-Social Behaviour Incidents and a 40 per cent weight for Deliberate Primary and Secondary Fires. This is unchanged from the approach used in the NIMDM 2010. It is not possible to use factor analysis to determine weights, as it requires at least three indicators.

11.6 The Crime and Disorder sub-domain scores were ranked and transformed to an exponential distribution. The values for each sub-domain were then combined in a 60:40 ratio for crime and disorder respectively, akin to the approach used in NIMDM 2005 and NIMDM 2010. There was no strong rationale for different weights from the consultation responses and discussions with the Domain Expert Group.

[9] See https://www.psni.police.uk/globalassets/inside-the-psni/our-statistics/police-recorded-crimestatistics/documents/crime-user-guide.pdf#page=12 and https://www.psni.police.uk/inside-psni/Statistics/police-recorded-crime-statistics/official-statistics/

Combination of indicators

11.7 Each of the indicators within the Crime and Disorder Domain were converted to rates of the at risk population before ranking and standardising to a normal distribution (see Annex B).

11.8 In NIMDM 2005 and NIMDM 2010, the standardised values of the indicators in the Crime sub-domain were combined with equal weights. In the English and Welsh deprivation measures, factor analysis is used to determine the weights of indicators in their equivalent domains. In contrast, the Scottish deprivation measure[10] used equal weights as there was no *'official methodology to differentiate between the severities of different types of crimes'*. The Steering Group, supported by the domain expert group, opted in favour of using factor analysis (see Annex C) as a data-driven method to determine the weight of indicators.

Indicator Weights[11]

Sub-Domain: Crime (0.6)

Violence (including sexual offences), robbery and public order	0.38
Burglary	0.04
Theft	0.05
Vehicle Crime	0.43
Criminal Damage and Arson	0.09

Sub-Domain: Disorder (0.4)

Deliberate Primary and Secondary Fires	0.40
Anti-Social Behaviour Incidents	0.60

[10] See http://www.gov.scot/Resource/0050/00504822.pdf#page=58

[11] Weights do not add up to 1.00 due to rounding.

Multiple Deprivation Measure (MDM)

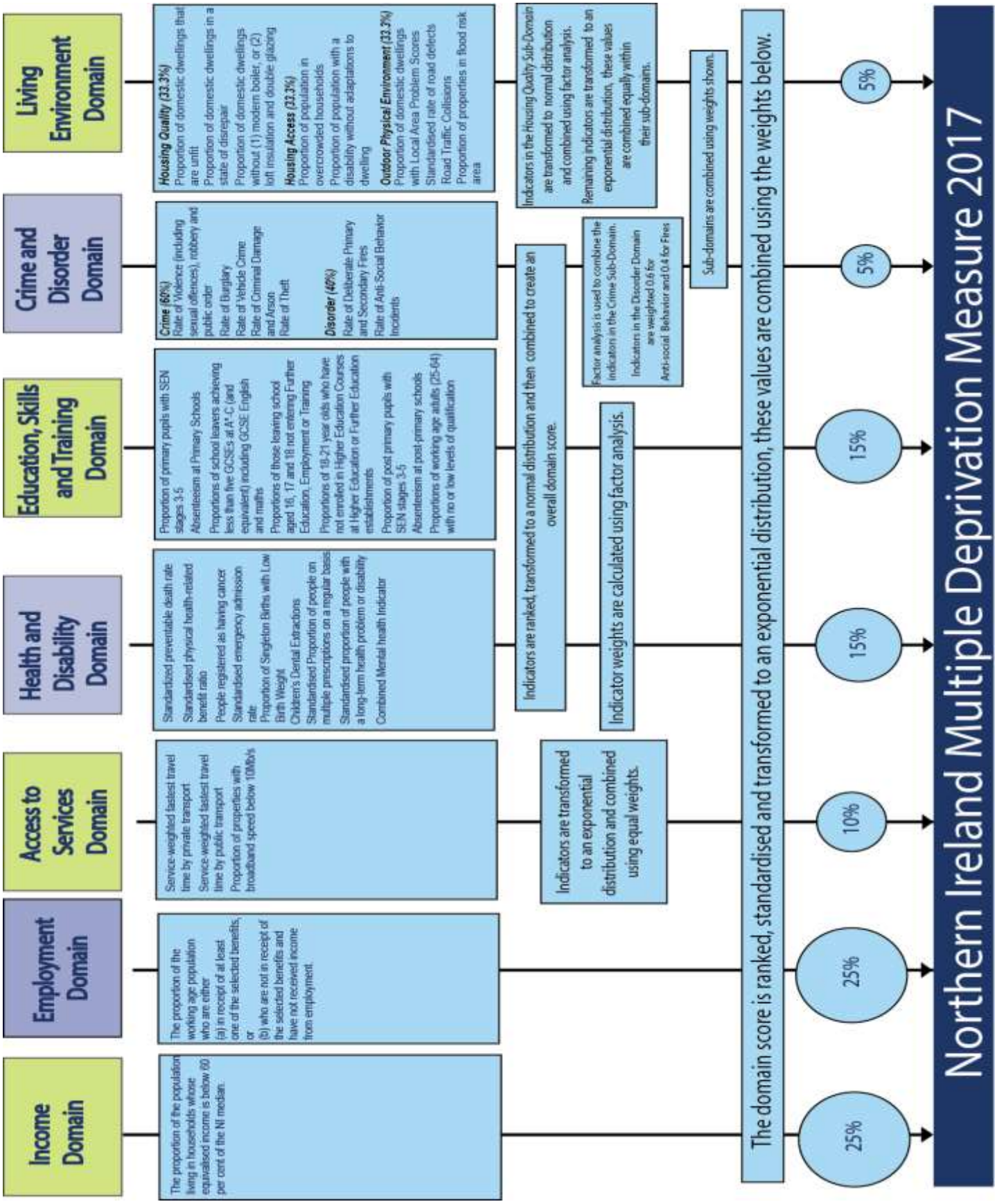
12.1 The Multiple Deprivation Measure brings together the ranking of the 7 domains into a single ranking. The ranks of each Domain were exponentially transformed (See Annex C), so that high ranking deprivation in one domain cannot be cancelled out by low levels of deprivation in another. This transformation gives a score of 100 to the most deprived, and zero to the least deprived area.

12.2 For each area, the exponentially transformed scores of the seven domains are aggregated by applying the following weights:

- Income Deprivation – 25 per cent
- Employment Deprivation – 25 per cent
- Health Deprivation and Disability – 15 per cent
- Education, Skills and Training Deprivation – 15 per cent
- Access to Services – 10 per cent
- Living Environment – 5 per cent
- Crime and Disorder – 5 per cent

12.3 A summary of the methodology can be found in Annex A.

Annex A: Methodology Summary

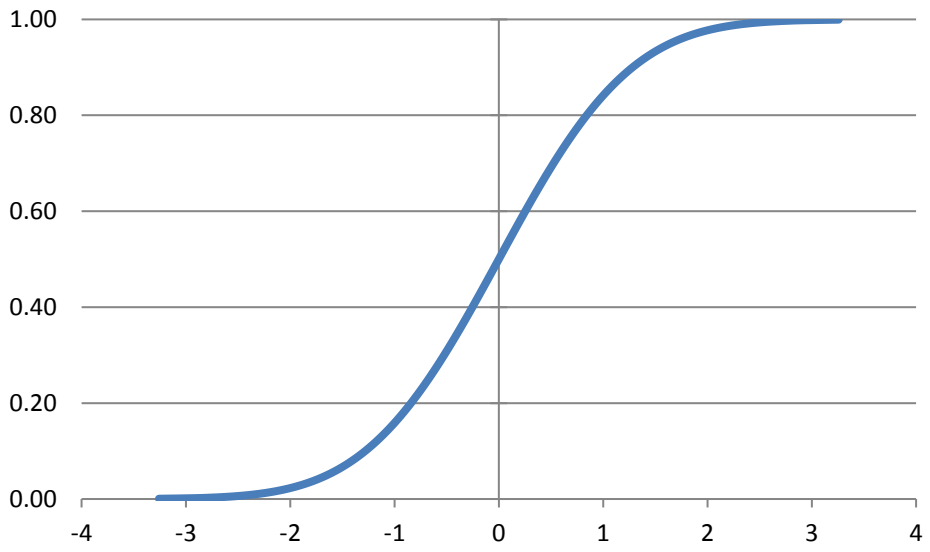


Annex B: Normal Transformation

Apart from the Income and Employment Deprivation Domains, all domains and sub-domains consist of multiple indicators. The majority of indicators are initially calculated as rates or ratios to control for variations in population size or other area characteristics.

To combine the indicators it is necessary they are measured on comparable scales, so that small values are not dominated unintentionally by large values. The indicator values are therefore ranked from most deprived (1) to least deprived (890). These ranks are then transformed so that ranks lie between 0 and 1. For example, the most deprived area becomes (1-0.5) / 890 = 0.00056, and the least deprived area becomes (890-0.5) / 890 = 0.99944.

In the next step, the transformed ranks are given a score converted from a normal distribution with average 0 and standard deviation 1. The graph below demonstrates this conversion.



The table below shows the steps in the transformation for some ranks.

	Rank (1-890)	Rank (0-1)	Score
Most deprived SOA	1	0.00056	-3.26
	89	0.09944	-1.28
	178	0.19944	-0.84
	267	0.29944	-0.53
	445	0.49944	0.00
	801	0.89944	1.28
Least deprived SOA	890	0.99944	3.26

The effect of normal transformation is that for each indicator, the most deprived area has the same value. For those domains or sub-domains with multiple indicators, the normalised indicator scores can be combined using a weighting that is either set or derived from data driven methods such as factor analysis.

Annex C: Factor Analysis

Several domains will use Factor Analysis as a data-driven method to estimate weights for indicators: Health Deprivation and Disability Domain, Education, Skills and Training Deprivation Domain, and the Crime sub-Domain.

This method hypothesises that an underlying factor exists that manifests itself in multiple ways that are correlated with this factor. This underlying factor cannot be measured directly but can be identified through its effect on individuals that can be measured as indicators. For example, health deprivation cannot be measured directly, but is postulated to be higher in areas with high mortality or morbidity rates – measured through diagnosis, prescriptions, hospital admissions or benefit entitlement. Such indicators can then be weighted and combined to create an area score, which should measure, as accurately as possible, the underlying factor.

Factor analysis can handle the fact that indicators (1) are measured on different scales, (2) have different levels of statistical accuracy, (3) have different distributions, (4) may or may not apply to the same individual and (5) measure, to different degrees, the underlying factor imperfectly.

With regards to point (4), factor analysis takes some account of the problem of 'double-counting' within domains. For example, a pupil with a low attendance will be less likely to meet the grades to enrol in higher education. Similarly, someone with a limiting long-term health problem is more likely to be in receipt of multiple prescriptions and/or health benefits. Factor analysis, however, takes some account of this overlap by lowering the weight of an indicator that is strongly correlated with one other indicator, but weakly correlated with the remaining indicators.

Maximum Likelihood (ML) Factor Analysis is a type of common factor analysis that has been selected to estimate indicator weights in NIMDM 2017. The method is most appropriate where indicators are not perfectly reliable or measured without error, and does not depends on the scale of measurement of the input indicators. Factor analysis can only be used if there are at least three indicators; only if all indicators are positively correlated with each other, will factor analysis result in positive weights that add up to one.

Annex D: Exponential Transformation

Exponential Transformation will be used to combine Domains into the Multiple Deprivation Measure, but also when combining sub-domains into one domain. The need for this transformation can be best demonstrated with a simplified scenario of two domains and five areas with the following ranks:

	Area A	Area B	Area C	Area D	Area E
Domain X	1	2	3	4	5
Domain Y	5	4	3	2	1

If both domains receive equal weight, then all areas will have the same average rank (i.e. three). If the domains receive different weights, than the ranking of areas based on the weighted average rank will reflect the ranking of the domain with the highest weight:

	Area A	Area B	Area C	Area D	Area E
Domain X (0.75)	1	2	3	4	5
Domain Y (0.25)	5	4	3	2	1
Average Weighted Rank	1*0.75 + 5*0.25 = 2	2*0.75 + 4*0.25 = 2.5	3*0.75 + 3*0.25 = 3	4*0.75 + 2*0.25 = 3.5	5*0.75 + 1*0.25 = 4
Combined rank	1	2	3	4	5

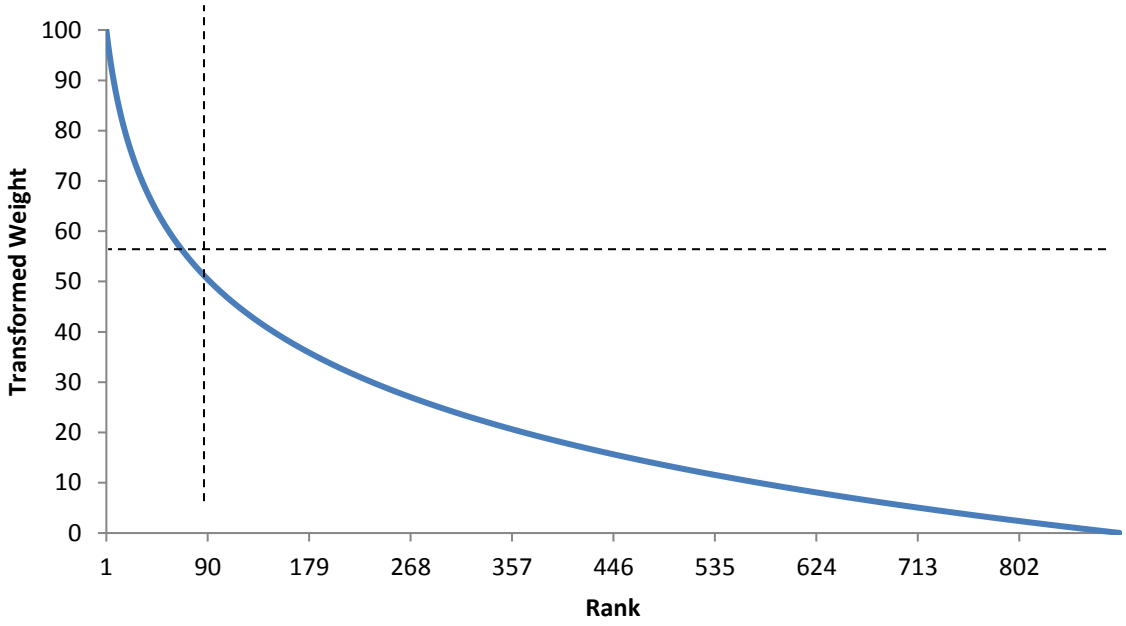
The problem with this scenario is that deprivation in one domain can be cancelled out by the lack of deprivation in another domain. Of course, this scenario would be less likely in a NIMDM with seven domains and 890 areas. One unintended consequence, however, is that if this approach was used in NIMDM 2010, there would have been 15 pairs of Super Output Areas with identical ranks.

Exponential Transformation gives more weight to the most deprived areas. The NIMDM 2010 report[12] quotes a formula to transform the rank of a domain to a weight, where the most deprived area receives a weight of 100, and the least deprived area 0. The parameters of that formula where set in such a way that all areas in the 10 per cent most deprived areas receive a weight of at least 50.

Exponential Transformation[13] was chosen as it best meets the criteria to

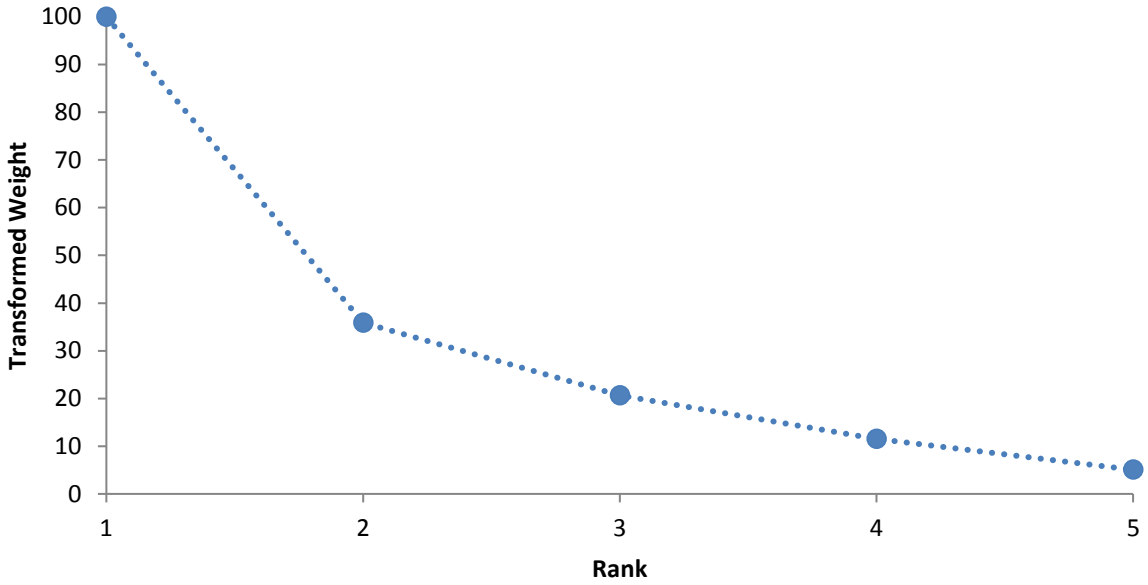
1. ensure that each Domain has a common distribution;
2. not be scale dependent;
3. have an appropriate degree of cancellation built into it; and
4. facilitate the identification of the most deprived areas.

The graph below shows the relationship between rank and weights.



When applying that same formula to the simplified example of five areas, the weights become 100, 36, 21, 12 and 5 from most to least deprived area.

[12] See https://www.nisra.gov.uk/sites/nisra.gov.uk/files/publications/NIMDM_2010_Report_0.pdf#page=68
[13] See http://webarchive.nationalarchives.gov.uk/20100410180038/http://www.communities.gov.uk/documents/communities/pdf/131209.pdf#page=44



The table below show the results.

	Area A	Area B	Area C	Area D	Area E
Domain X (0.75)	1	2	3	4	5
Domain Y (0.25)	5	4	3	2	1
Transformed X	100	36	21	12	5
Transformed Y	5	12	21	36	100
Weighted transformed weight	100*0.75 + 5*0.25 = 76	36*0.75 + 12*0.25 = 30	21*0.75 + 21*0.25 = 21	12*0.75 + 36*0.25 = 18	5*0.75 + 100*0.25 = 29
Combined rank	1	2	4	5	3

Area A, which is most deprived in the domain with the highest weight, will also be most deprived when both domains are combined. Area E, which is most deprived in the domain with the smallest weight, becomes the third most deprived area overall.

Annex E: Shrinkage

Creating reliable indicators for small geographical areas can be challenging, particularly if there are only a small number of observations. This is particularly an issue for Small Areas (SAs), with an average population around 400 people. One solution is to collect information over a longer time period. However, more recent information from the surrounding areas can add statistical strength rather than through adding older data. Shrinkage is a method used to bring a less reliable indicator score more into line with that of its larger geography. The extent of movement depends on both the reliability of the indicator and the heterogeneity of the larger geography. The shrinkage effect is greatest for areas with no or small number of observations in a relatively homogeneous larger geography.

Shrinkage was used in NIMDM 2005[14] to adjust SOA-level scores with those from the former 26 Local Government Districts (LGDs). However, this practice was abandoned in NIMDM 2010[15], in favour of using data over a longer time period and in some cases, substituting the SOA-level value for those at Ward-level. Deprivation measures for Scotland and Wales also abandoned shrinkage around that time; only the English Index of Multiple Deprivation still used it in its 2015 release[16].

Similar to NIMDM 2010, shrinkages will not be used to adjust SOA-level values. However, under certain conditions, shrinkage will be used to adjust Small Area values with equivalent values of the SOA they are in.

In short, the adjusted value is a weighted average of the SA and SOA values:

$$m_j^* = w_j \times m_j + \left(1 - w_j\right) \times M$$

[14] https://www.nisra.gov.uk/sites/nisra.gov.uk/files/publications/NIMDM2005FullReport.pdf#page=9

[15] https://www.nisra.gov.uk/sites/nisra.gov.uk/files/publications/NIMDM_2010_Report_0.pdf#page=66

[16] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/464485/English_Indices_of_Deprivation_2015_-_Technical-Report.pdf#page=20

where m_j* is the adjusted SA-level value, w_j ·is the SA-specific weight, m_j is the raw SA-level value, and M is the SOA-level value. The SA-specific weight is determined by the following formula:

$$w_j = \frac{1/s_j^2}{1/s_j^2 + 1/t^2}$$

where t^2 is the inter-SA variance for the k SAs in the SOA, calculated as

$$t^2 = \frac{1}{k-1} \times \sum_{j=1}^{k} \left(m_j - M\right)^2$$

The standard error of the SA-level value (s_j^2) depends on the type of value. For proportions, i.e. where there are r_j events out of a population of n_j, the formula is as follows:

$$s_j^2 = \frac{\left(n_j + 1\right)\left(n_j + 2\right)}{n_j\left(r_j + 1\right)\left(n_j - r_j + 1\right)}$$

For (Standardised) ratios, the adjusted value is also a weighted average of the SA and SOA values:

$$m_j^* = w_j \times m_j + \left(1 - w_j\right) \times M$$

where m_j* is the adjusted SA-level value, w_j is the SA-specific weight, m_j is the SA-level standardised ratio, and M is the SOA-level standardised ratio. The SA-specific weight for standardised ratios is determined by the following formula:

$$w_j = \frac{s_j^2}{s_j^2 + 1/t^2}$$

where t^2 is the inter-SA variance for the k SAs in the SOA, calculated as

$$t^2 = \frac{1}{k-1} \times \sum_{j=1}^{k} \left(m_j - M\right)^2$$

The standard error of the SA-level value (s_j^2) depends on the type of value. For standardised ratios it is calculated as below, where there are r_j is the expected number of events in an SA after age and gender standardisation:

$$s_j^2 = \sqrt{\frac{t^2}{(r_j)}}$$

Glossary

BSO	Business Services Organisation
CCEA	Council for the Curriculum, Examinations and Assessment
DE	Department of Education
DfC	Department for Communities
DfE	Department for the Economy
DfI	Department for Infrastructure
DoH	Department of Health
FESR	Further Education Statistical Record
GCSE	General Certificate of Secondary Education
GP	General Practitioner
GRO	General Register Office
HESA	Higher Education Statistics Agency
HMRC	Her Majesty's Revenue and Customs
IDBR	Inter- Departmental Business Register
NIFRS	Northern Ireland Fire and Rescue Service
NIHE	Northern Ireland Housing Executive
NIMDM	Northern Ireland Multiple Deprivation Measure
NISRA	Northern Ireland Statistics and Research Agency
OFCOM	Office of Communications
ONS	Office of National Statistics
PSNI	Police Service of Northern Ireland
SCG	Statistics Co-ordinating Group
SEN	Special Educational Needs
SOA	Super Output Area
SA	Small Area